FIG. 1
(PRIOR ART)

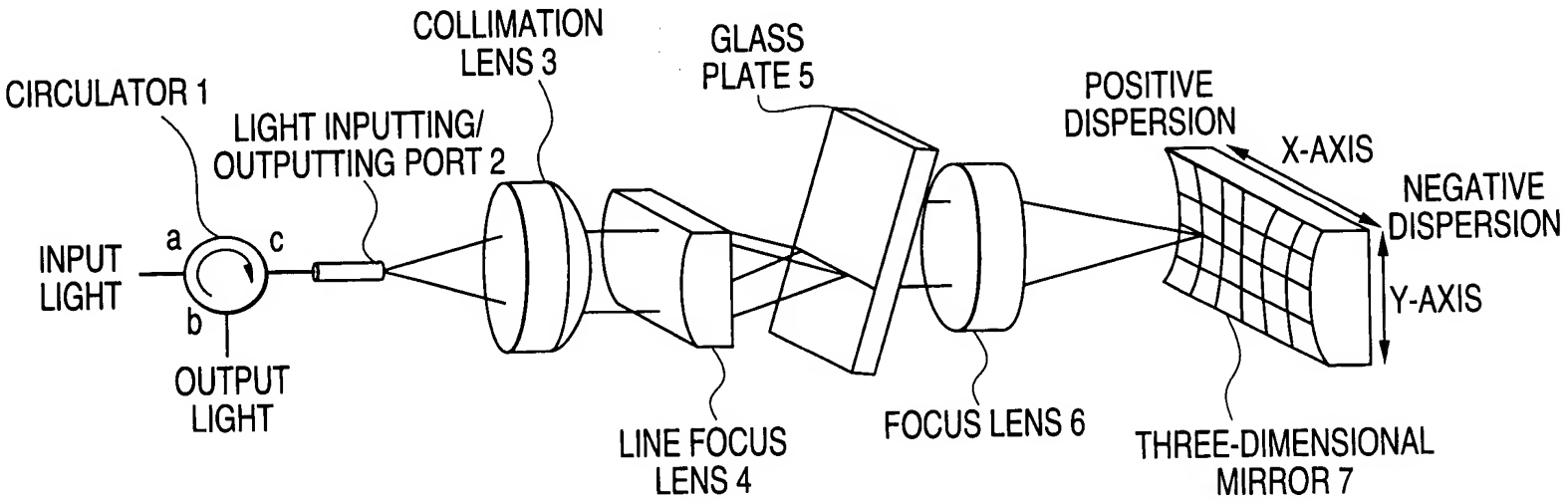


FIG. 2

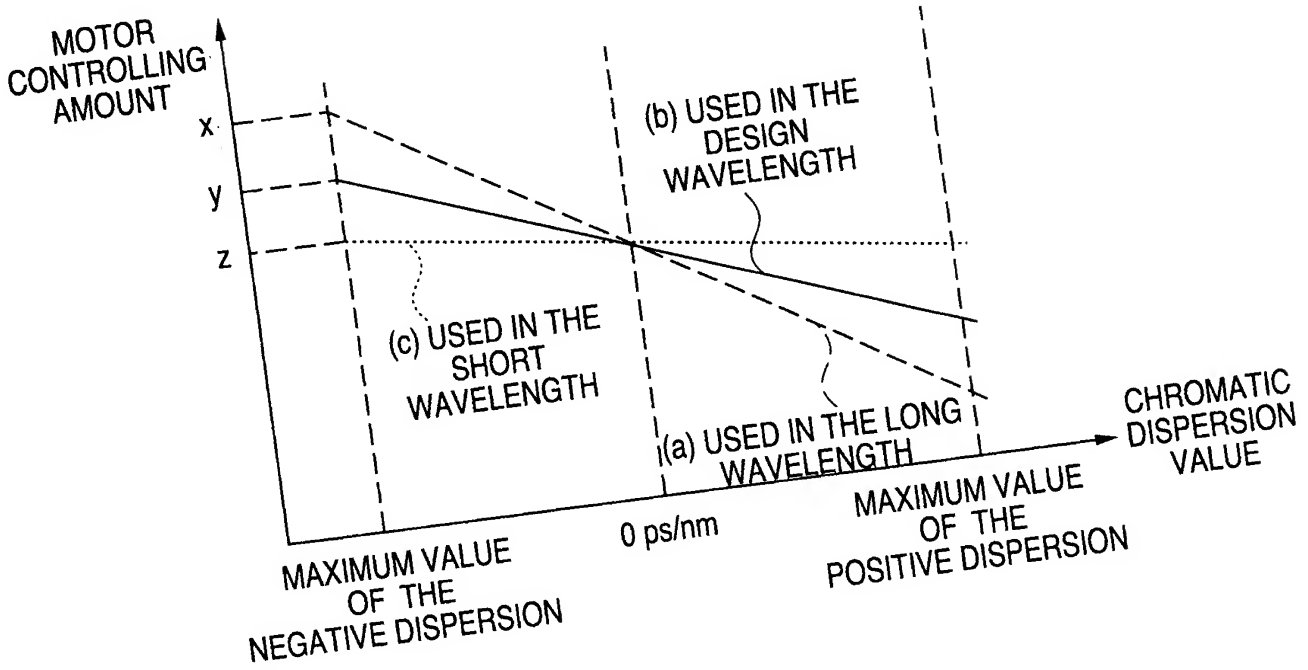

MOTOR CONTROLLING AMOUNT
x
y
z
(b) USED IN THE DESIGN WAVELENGTH
(c) USED IN THE SHORT WAVELENGTH
(a) USED IN THE LONG WAVELENGTH
CHROMATIC DISPERSION VALUE
MAXIMUM VALUE OF THE NEGATIVE DISPERSION
0 ps/nm
MAXIMUM VALUE OF THE POSITIVE DISPERSION

FIG. 3

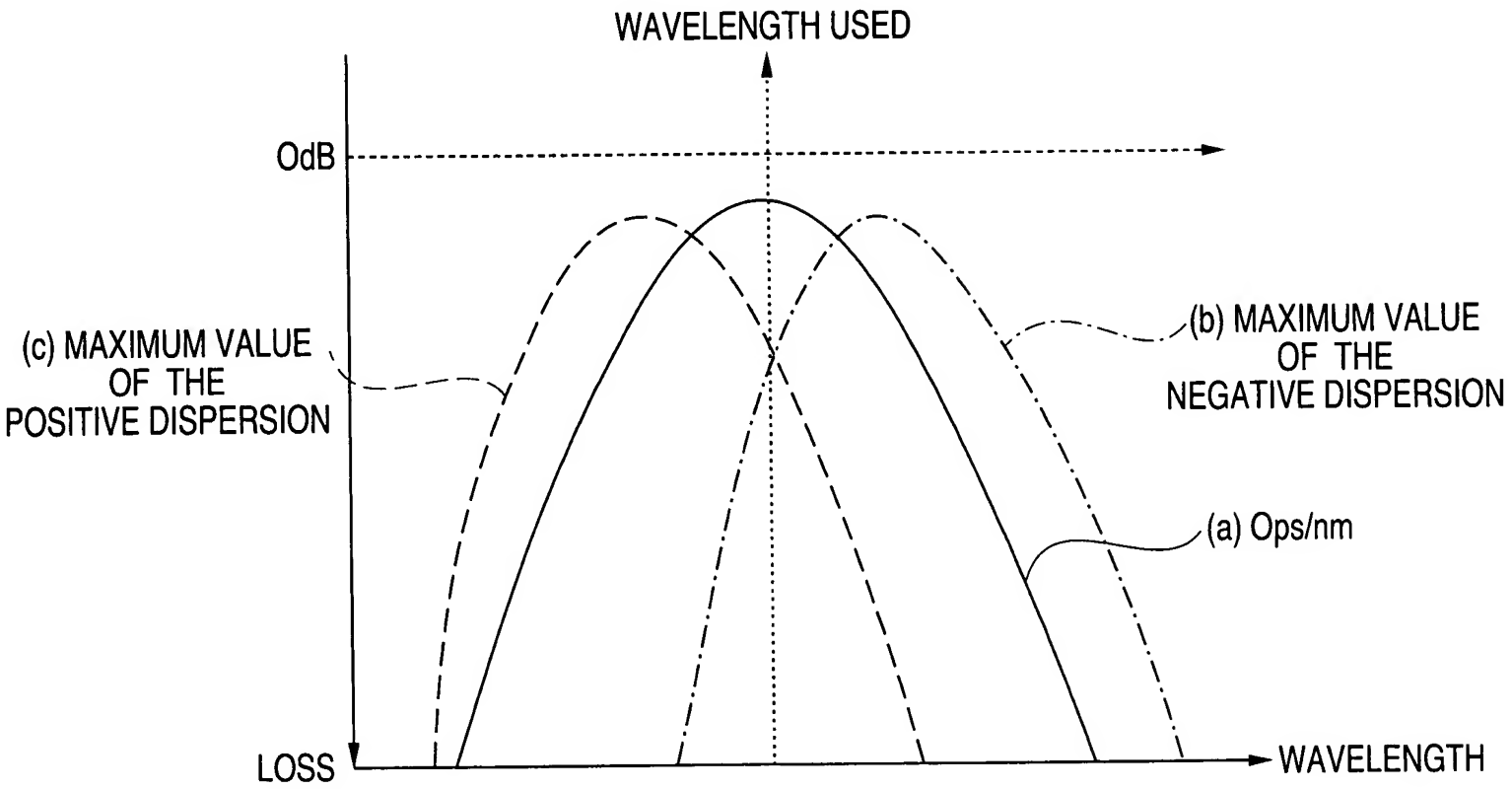

WAVELENGTH USED
OdB
(c) MAXIMUM VALUE OF THE POSITIVE DISPERSION
(b) MAXIMUM VALUE OF THE NEGATIVE DISPERSION
(a) Ops/nm
LOSS
WAVELENGTH

FIG. 4

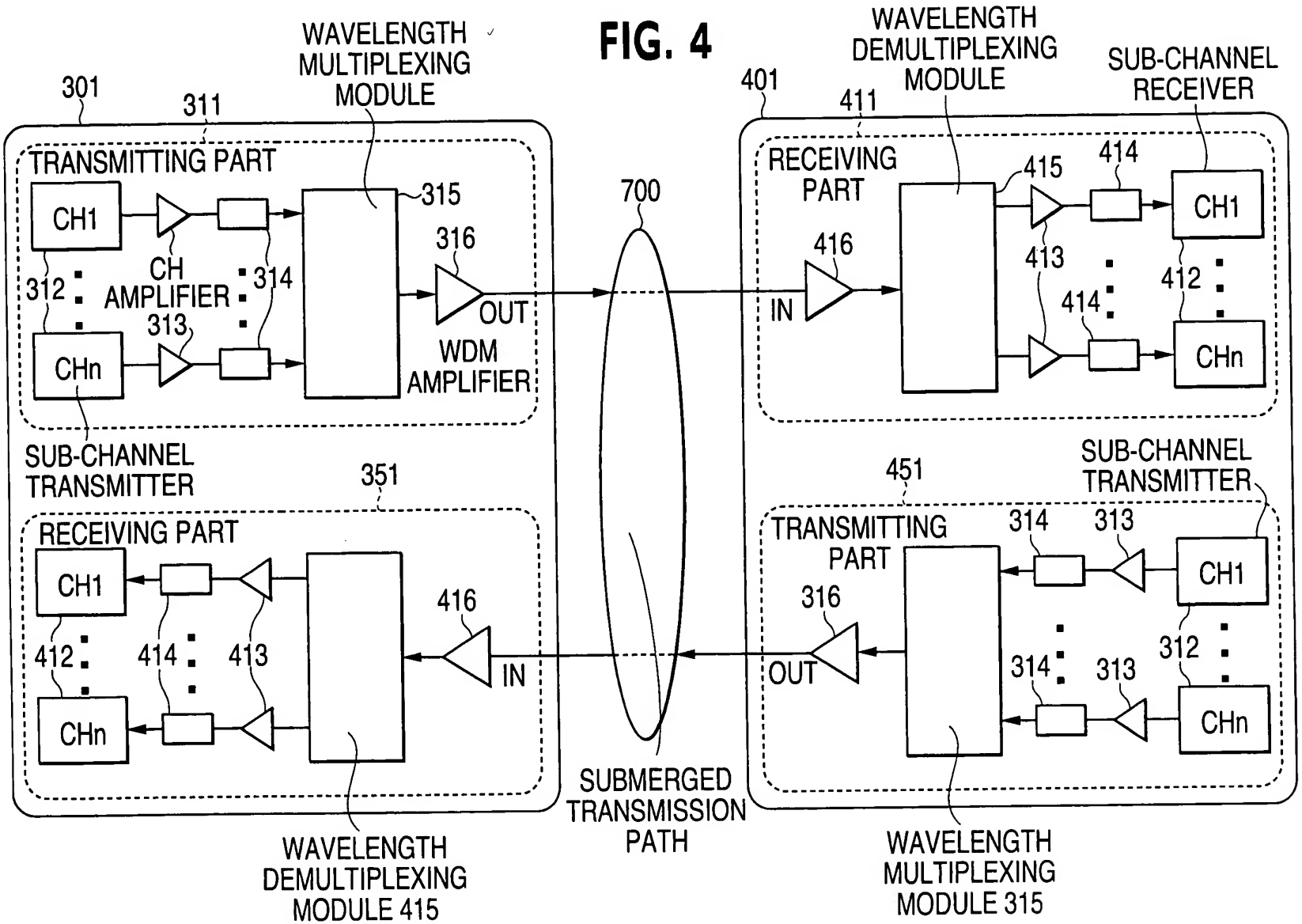

301
311
WAVELENGTH MULTIPLEXING MODULE
TRANSMITTING PART
CH1
CHn
CH AMPLIFIER
312
313
314
315
316
OUT
WDM AMPLIFIER
SUB-CHANNEL TRANSMITTER
351
RECEIVING PART
CH1
CHn
412
414
413
416
IN
WAVELENGTH DEMULTIPLEXING MODULE 415
700
SUBMERGED TRANSMISSION PATH
401
411
WAVELENGTH DEMULTIPLEXING MODULE
SUB-CHANNEL RECEIVER
RECEIVING PART
415
414
CH1
416
IN
413
412
414
CHn
451
SUB-CHANNEL TRANSMITTER
TRANSMITTING PART
314
313
CH1
316
OUT
312
314
313
CHn
WAVELENGTH MULTIPLEXING MODULE 315

FIG. 5

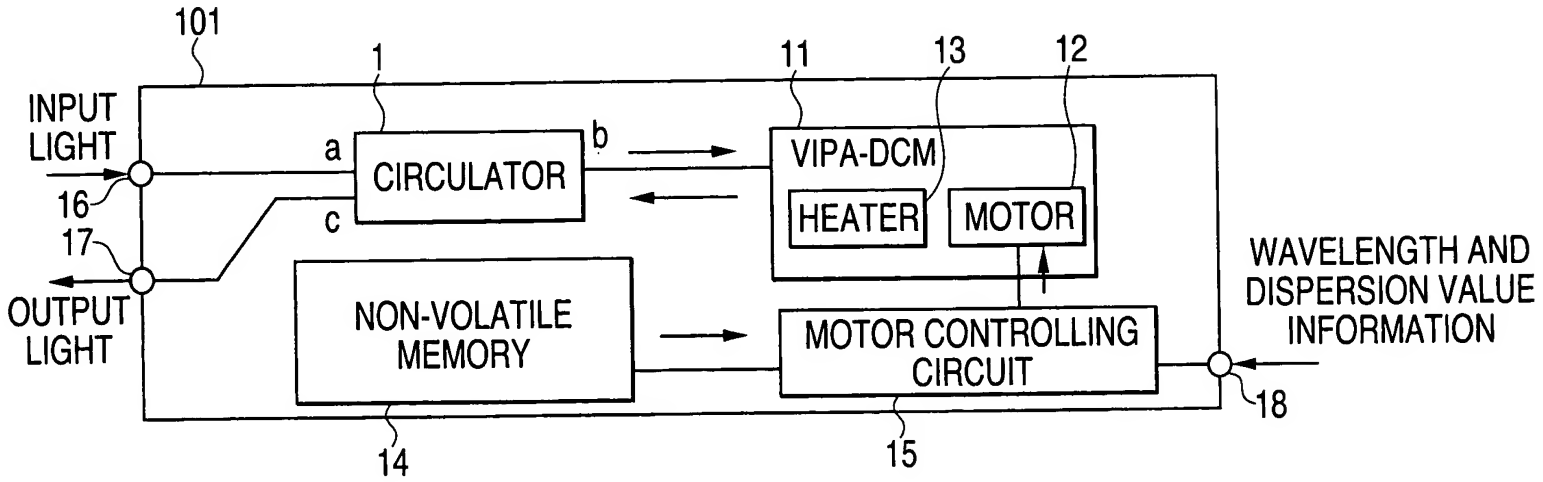

101
1
11
13
12
INPUT LIGHT
a
CIRCULATOR
b
VIPA-DCM
HEATER
MOTOR
16
c
17
OUTPUT LIGHT
NON-VOLATILE MEMORY
MOTOR CONTROLLING CIRCUIT
WAVELENGTH AND DISPERSION VALUE INFORMATION
18
14
15

FIG.6

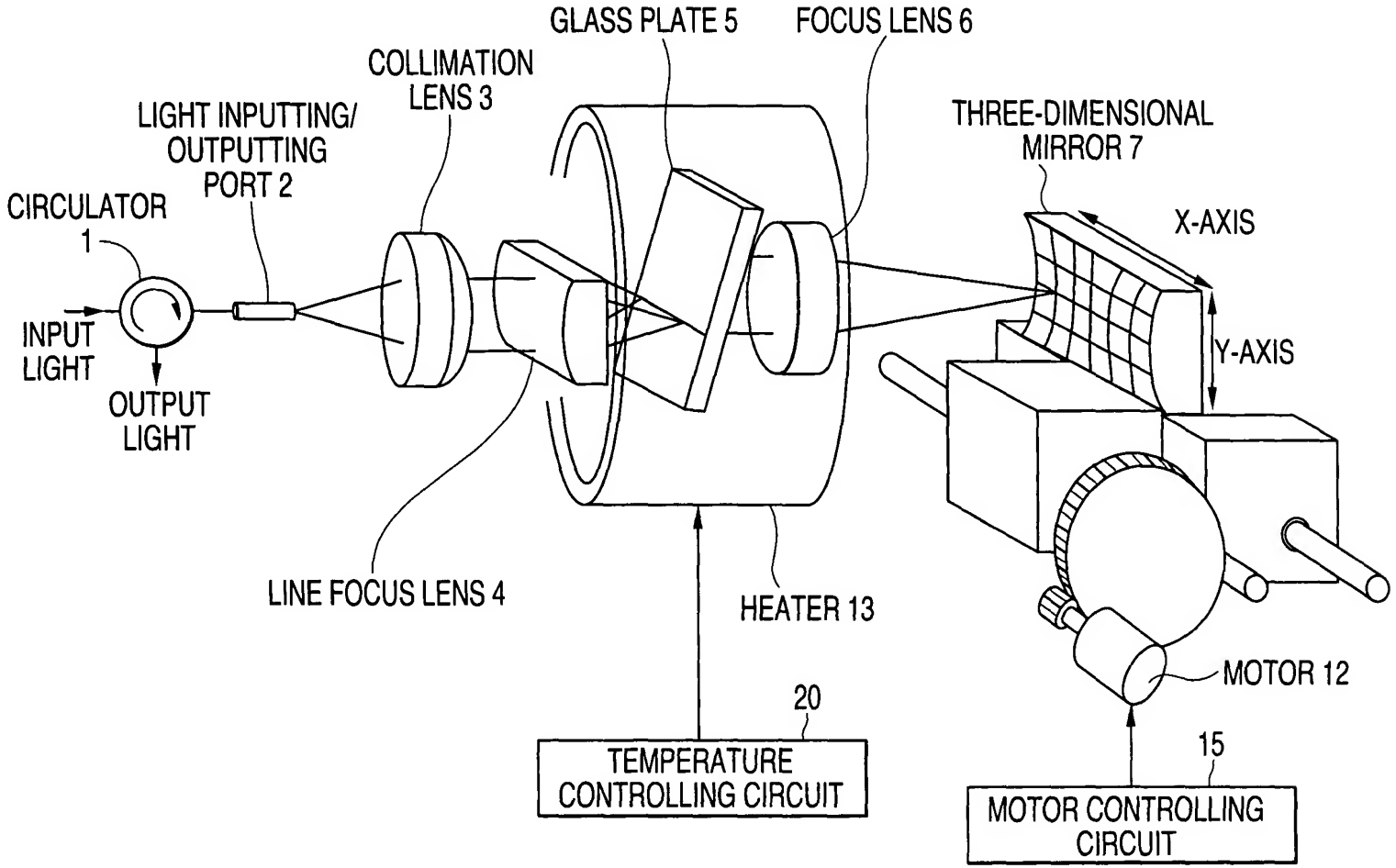

GLASS PLATE 5
FOCUS LENS 6
COLLIMATION LENS 3
LIGHT INPUTTING/ OUTPUTTING PORT 2
THREE-DIMENSIONAL MIRROR 7
CIRCULATOR 1
X-AXIS
INPUT LIGHT
Y-AXIS
OUTPUT LIGHT
LINE FOCUS LENS 4
HEATER 13
MOTOR 12
20
TEMPERATURE CONTROLLING CIRCUIT
15
MOTOR CONTROLLING CIRCUIT

FIG. 7

WAVELENGTH USED (nm)	CHROMATIC DISPERSION VALUE (ps/nm)	MOTOR CONTROLLING AMOUNT (pulse)
1567.440	-2000	5000
	-1990	4992
	...	...
	+2000	2000
1566.211	-2000	5002
	-1990	4994
	...	...
	+2000	1998
...	...	...
1534.937	-2000	5002
	-1990	4984
	...	...
	+2000	1988

FIG. 8

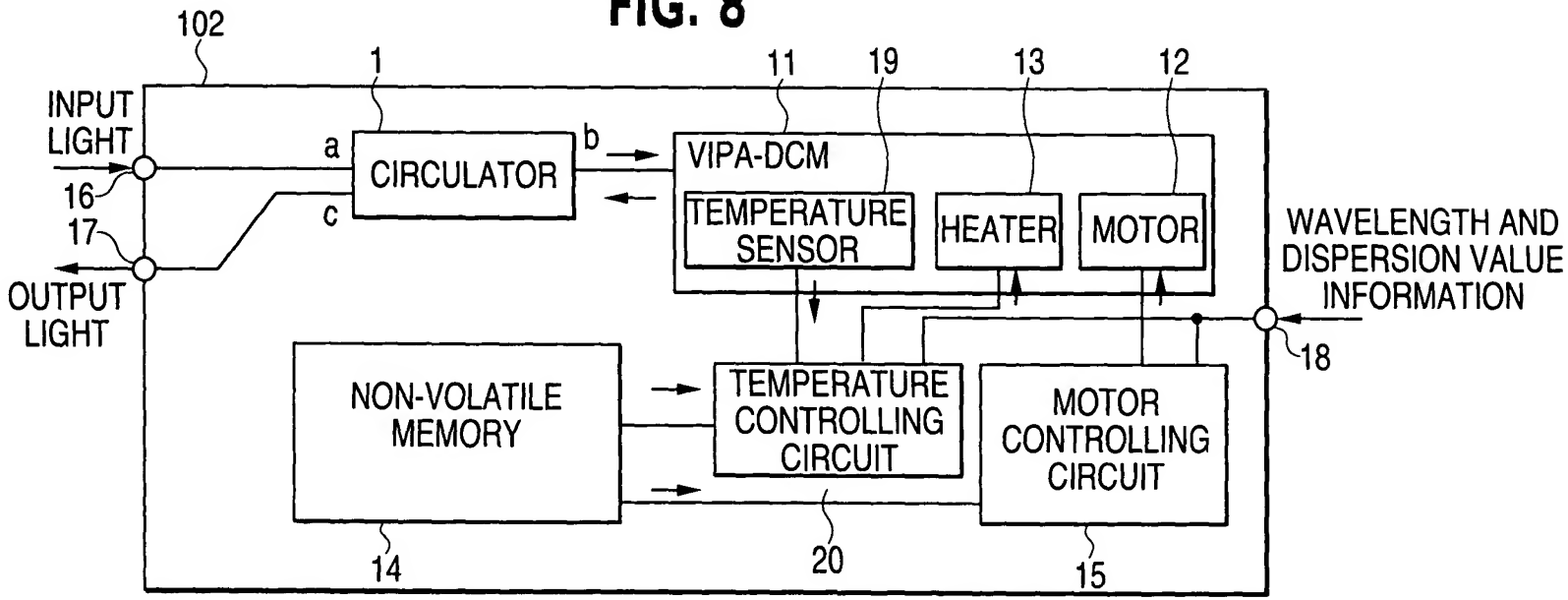

102
1
11
19
13
12
INPUT LIGHT
16
17
OUTPUT LIGHT
a
b
c
CIRCULATOR
VIPA-DCM
TEMPERATURE SENSOR
HEATER
MOTOR
WAVELENGTH AND DISPERSION VALUE INFORMATION
18
NON-VOLATILE MEMORY
TEMPERATURE CONTROLLING CIRCUIT
MOTOR CONTROLLING CIRCUIT
14
20
15

FIG. 9

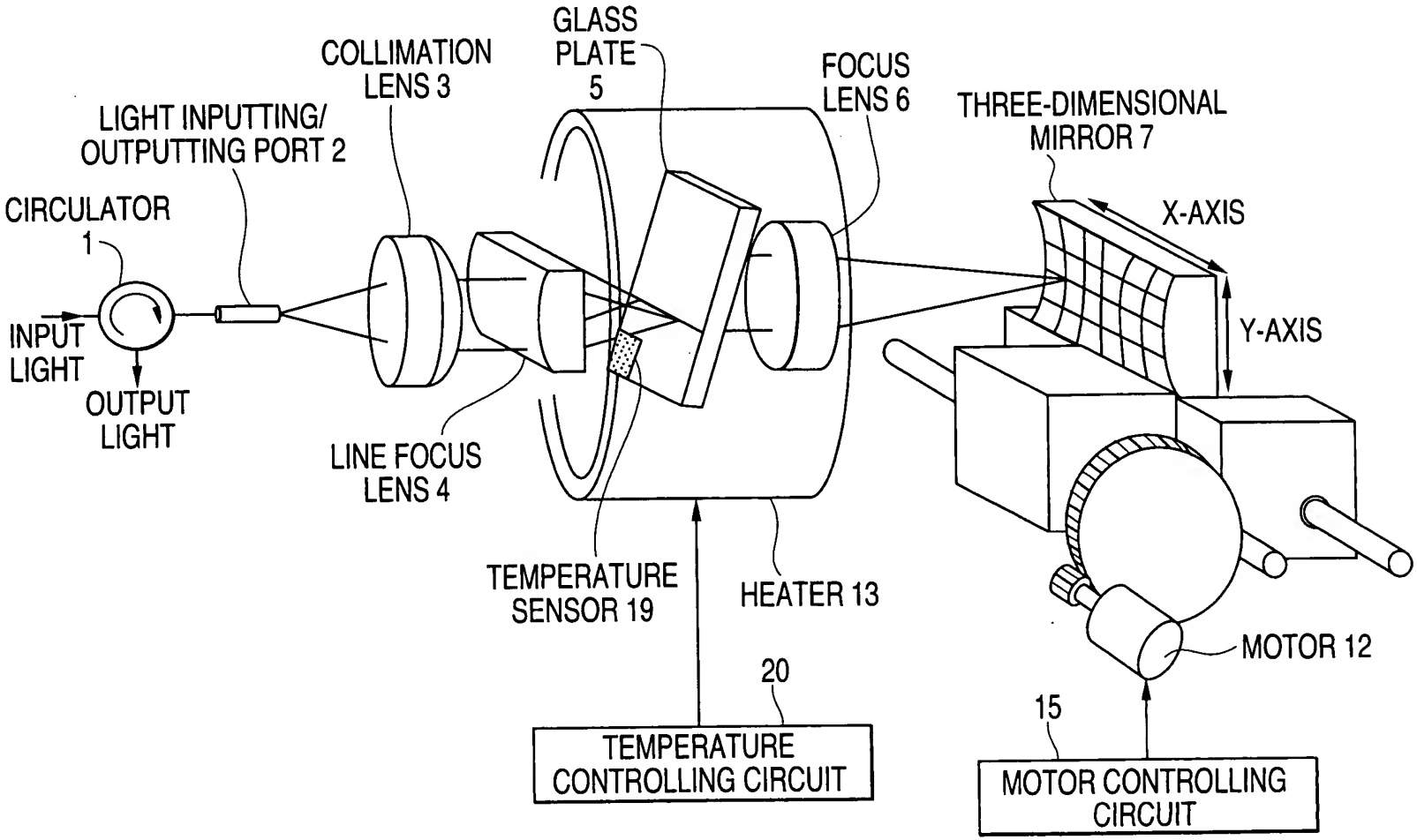

GLASS PLATE 5
COLLIMATION LENS 3
FOCUS LENS 6
THREE-DIMENSIONAL MIRROR 7
LIGHT INPUTTING/ OUTPUTTING PORT 2
CIRCULATOR 1
X-AXIS
Y-AXIS
INPUT LIGHT
OUTPUT LIGHT
LINE FOCUS LENS 4
TEMPERATURE SENSOR 19
HEATER 13
MOTOR 12
20
15
TEMPERATURE CONTROLLING CIRCUIT
MOTOR CONTROLLING CIRCUIT

FIG. 10

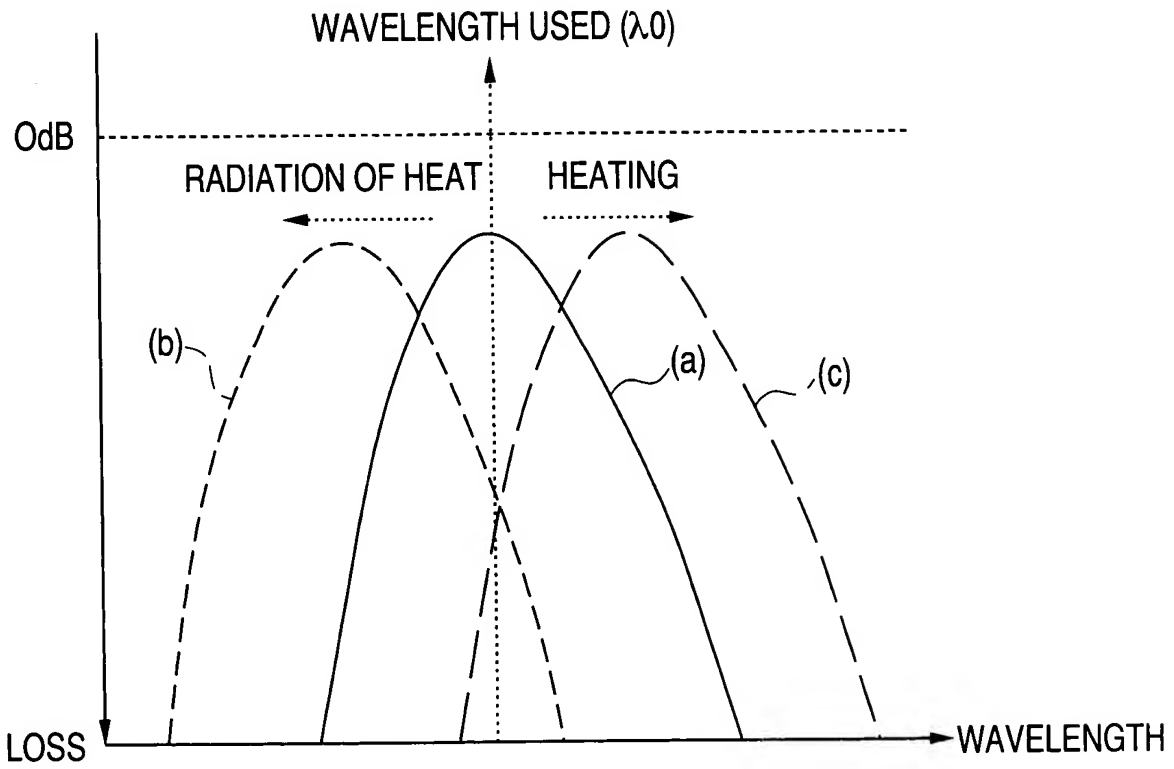

WAVELENGTH USED (λ0)
OdB
RADIATION OF HEAT
HEATING
(b)
(a)
(c)
LOSS
WAVELENGTH

FIG. 11

WAVELENGTH USED (nm)	DISPERSION VALUE (ps/nm)	MOTOR CONTROLLING AMOUNT (pulse)	TEMPERATURE (°C)
1567.440	-2000	5000	79.3
	-1990	4992	79.2
	...	...	...
	+2000	2000	75.2
1566.211	-2000	5002	79.2
	-1990	4994	79.1
	...	...	...
	+2000	1998	75.1
	...	...	...
1534.937	-2000	5002	78.3
	-1990	4984	78.2
	...	...	...
	+2000	1988	75.0

FIG. 12

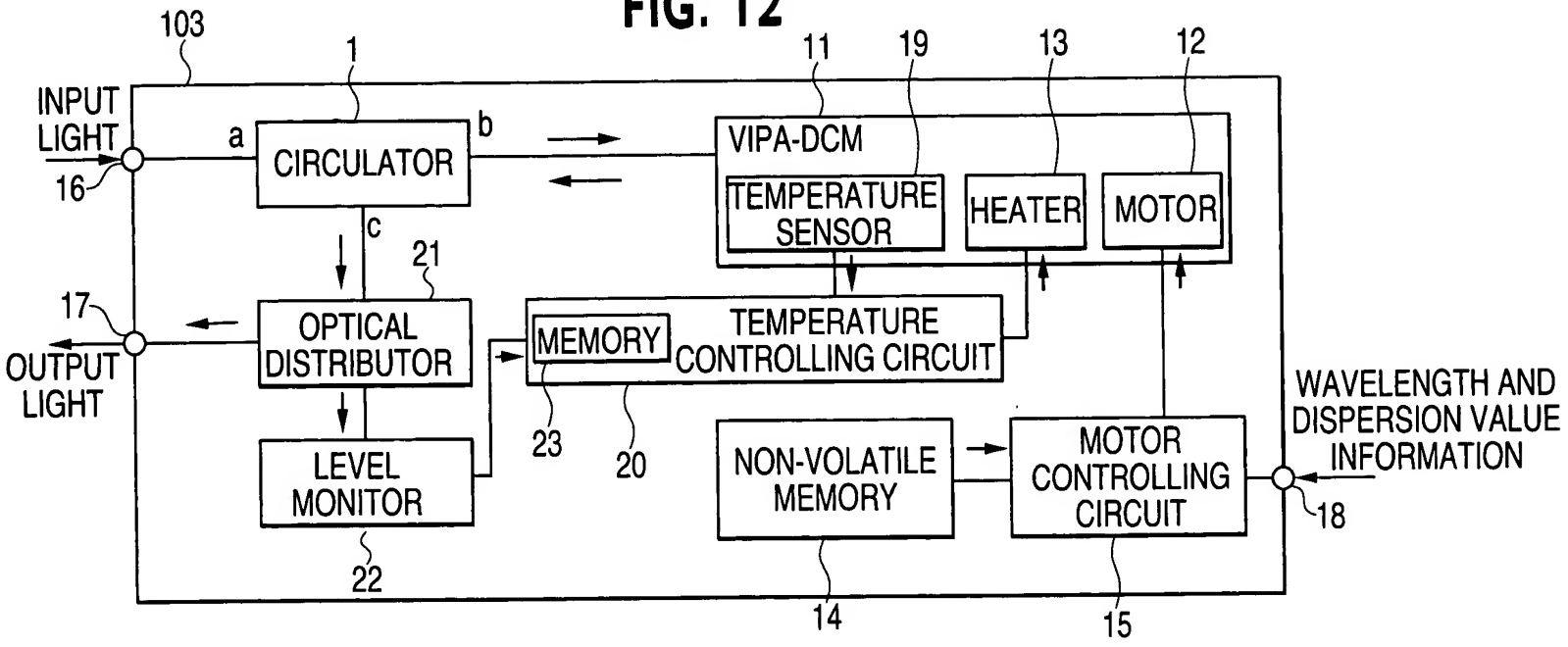
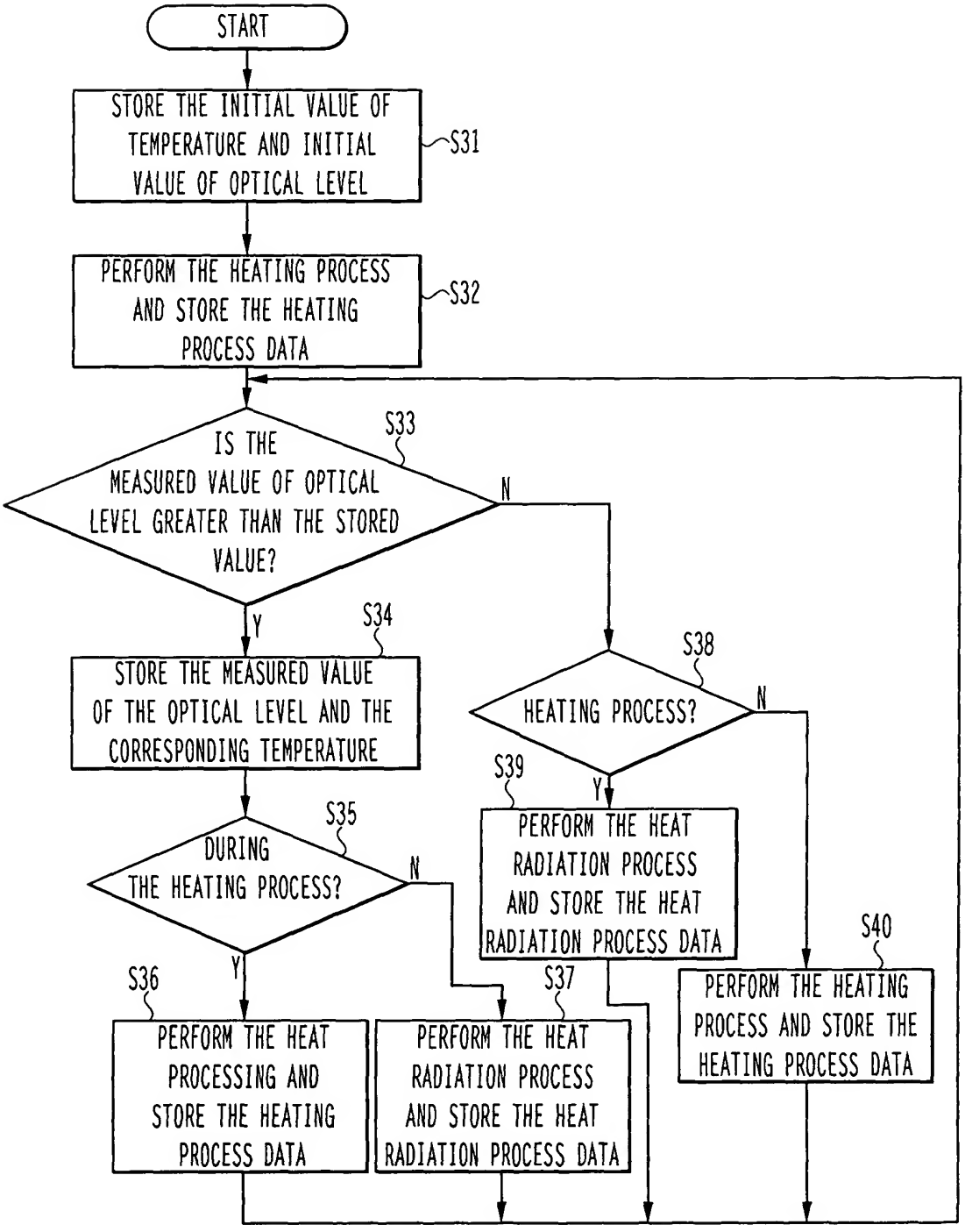

103
1
11
19
13
12
INPUT LIGHT
16
a
CIRCULATOR
b
VIPA-DCM
TEMPERATURE SENSOR
HEATER
MOTOR
c
21
17
OUTPUT LIGHT
OPTICAL DISTRIBUTOR
MEMORY
TEMPERATURE CONTROLLING CIRCUIT
WAVELENGTH AND DISPERSION VALUE INFORMATION
23
20
LEVEL MONITOR
NON-VOLATILE MEMORY
MOTOR CONTROLLING CIRCUIT
18
22
14
15

FIG. 13


START
STORE THE INITIAL VALUE OF TEMPERATURE AND INITIAL VALUE OF OPTICAL LEVEL
S31
PERFORM THE HEATING PROCESS AND STORE THE HEATING PROCESS DATA
S32
S33
IS THE MEASURED VALUE OF OPTICAL LEVEL GREATER THAN THE STORED VALUE?
N
Y
S34
STORE THE MEASURED VALUE OF THE OPTICAL LEVEL AND THE CORRESPONDING TEMPERATURE
S35
DURING THE HEATING PROCESS?
N
Y
S36
PERFORM THE HEAT PROCESSING AND STORE THE HEATING PROCESS DATA
S37
PERFORM THE HEAT RADIATION PROCESS AND STORE THE HEAT RADIATION PROCESS DATA
S38
HEATING PROCESS?
N
Y
S39
PERFORM THE HEAT RADIATION PROCESS AND STORE THE HEAT RADIATION PROCESS DATA
S40
PERFORM THE HEATING PROCESS AND STORE THE HEATING PROCESS DATA

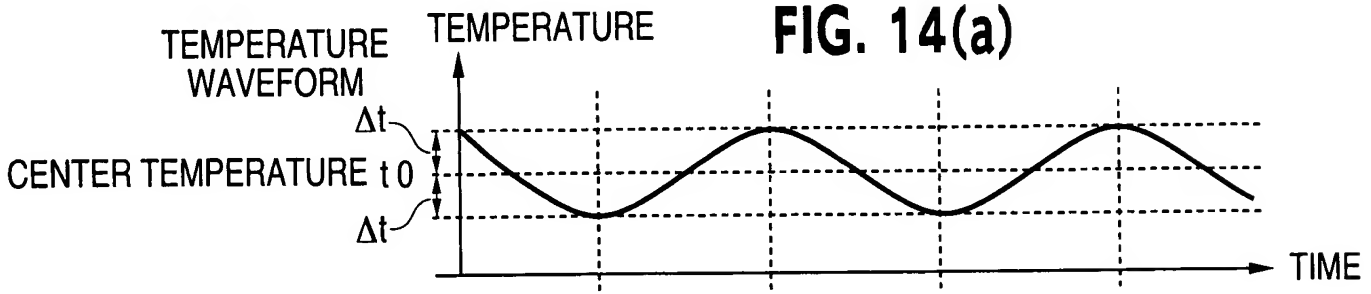


FIG. 14(a)

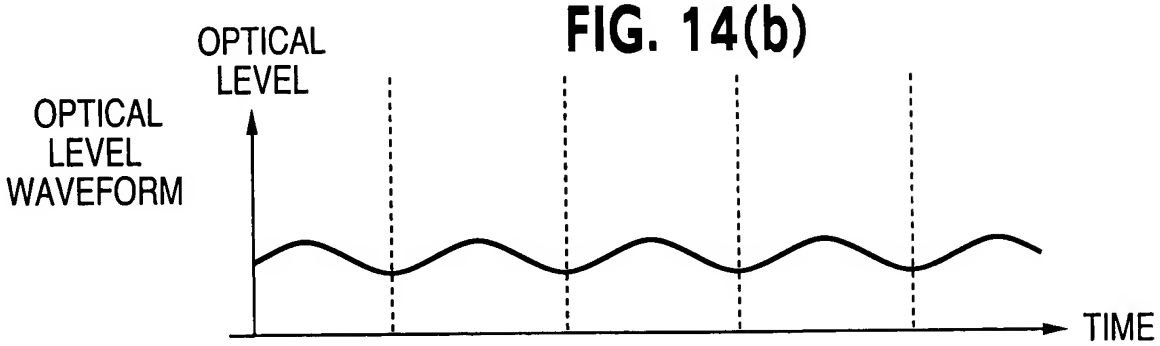


FIG. 14(b)

FIG. 15(a)

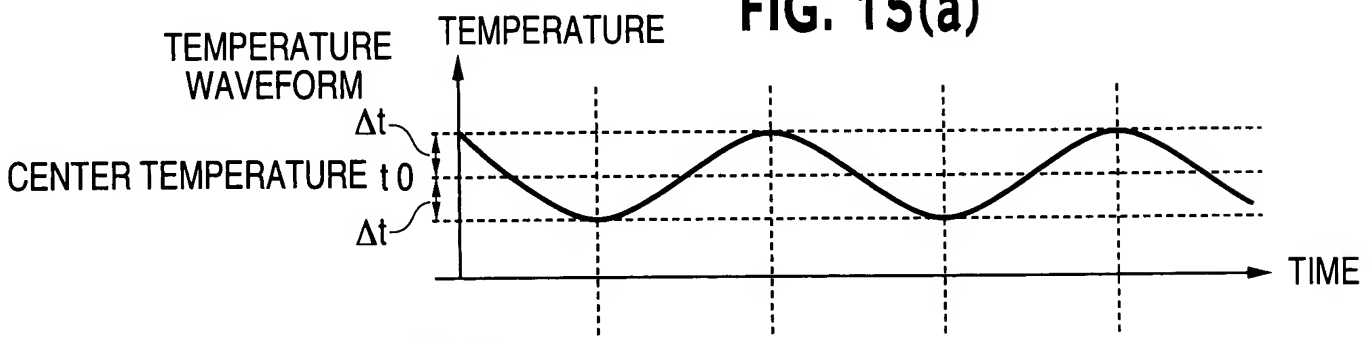


FIG. 15(b)

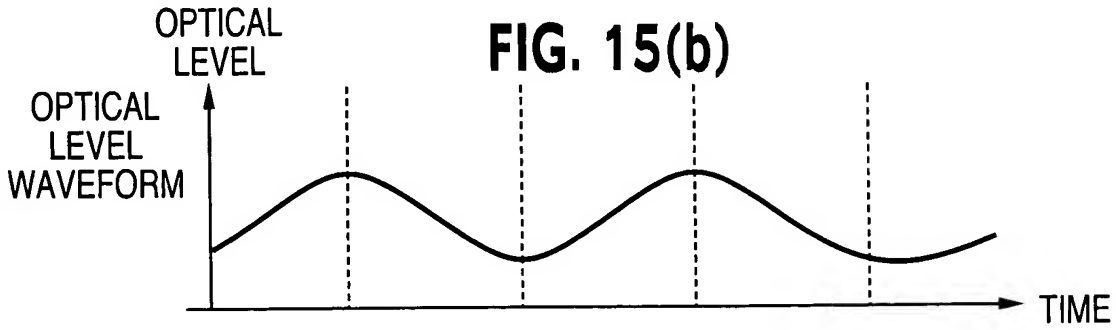


FIG. 16(a)

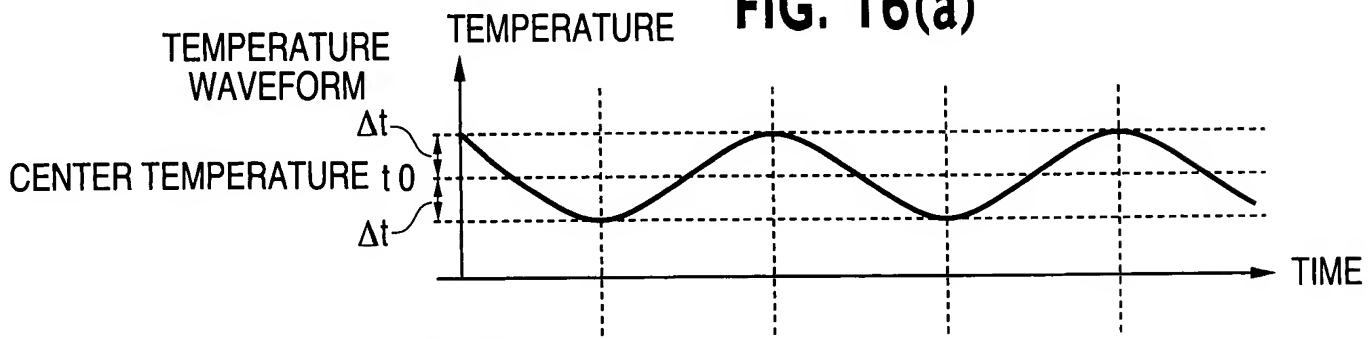


FIG. 16(b)

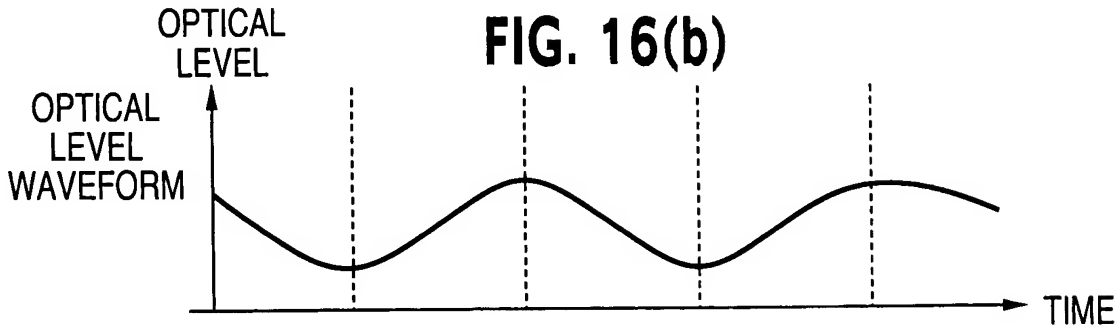


FIG. 17

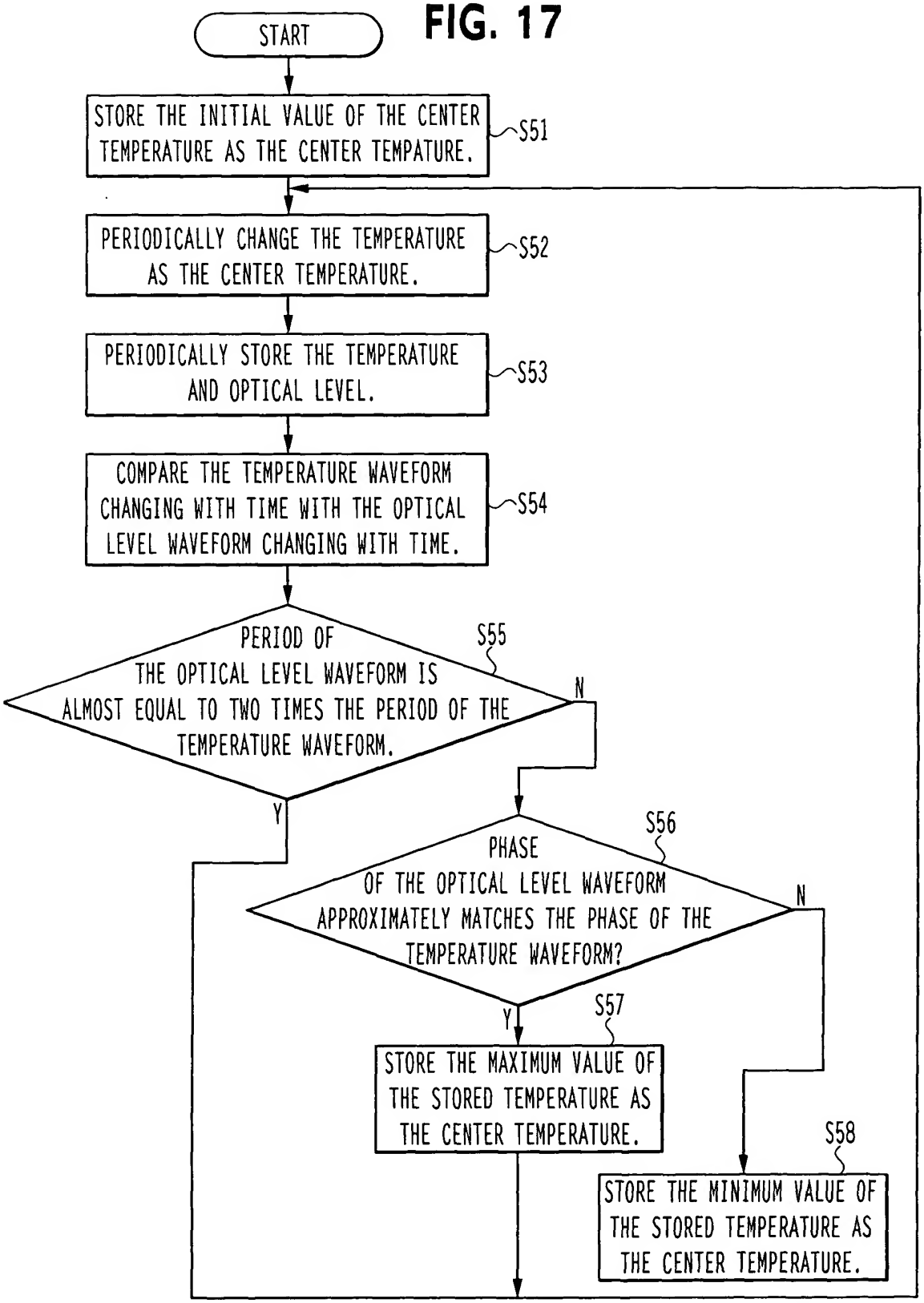

START
STORE THE INITIAL VALUE OF THE CENTER TEMPERATURE AS THE CENTER TEMPATURE.
S51
PERIODICALLY CHANGE THE TEMPERATURE AS THE CENTER TEMPERATURE.
S52
PERIODICALLY STORE THE TEMPERATURE AND OPTICAL LEVEL.
S53
COMPARE THE TEMPERATURE WAVEFORM CHANGING WITH TIME WITH THE OPTICAL LEVEL WAVEFORM CHANGING WITH TIME.
S54
PERIOD OF THE OPTICAL LEVEL WAVEFORM IS ALMOST EQUAL TO TWO TIMES THE PERIOD OF THE TEMPERATURE WAVEFORM.
S55
N
Y
PHASE OF THE OPTICAL LEVEL WAVEFORM APPROXIMATELY MATCHES THE PHASE OF THE TEMPERATURE WAVEFORM?
S56
N
Y
STORE THE MAXIMUM VALUE OF THE STORED TEMPERATURE AS THE CENTER TEMPERATURE.
S57
STORE THE MINIMUM VALUE OF THE STORED TEMPERATURE AS THE CENTER TEMPERATURE.
S58

FIG. 18

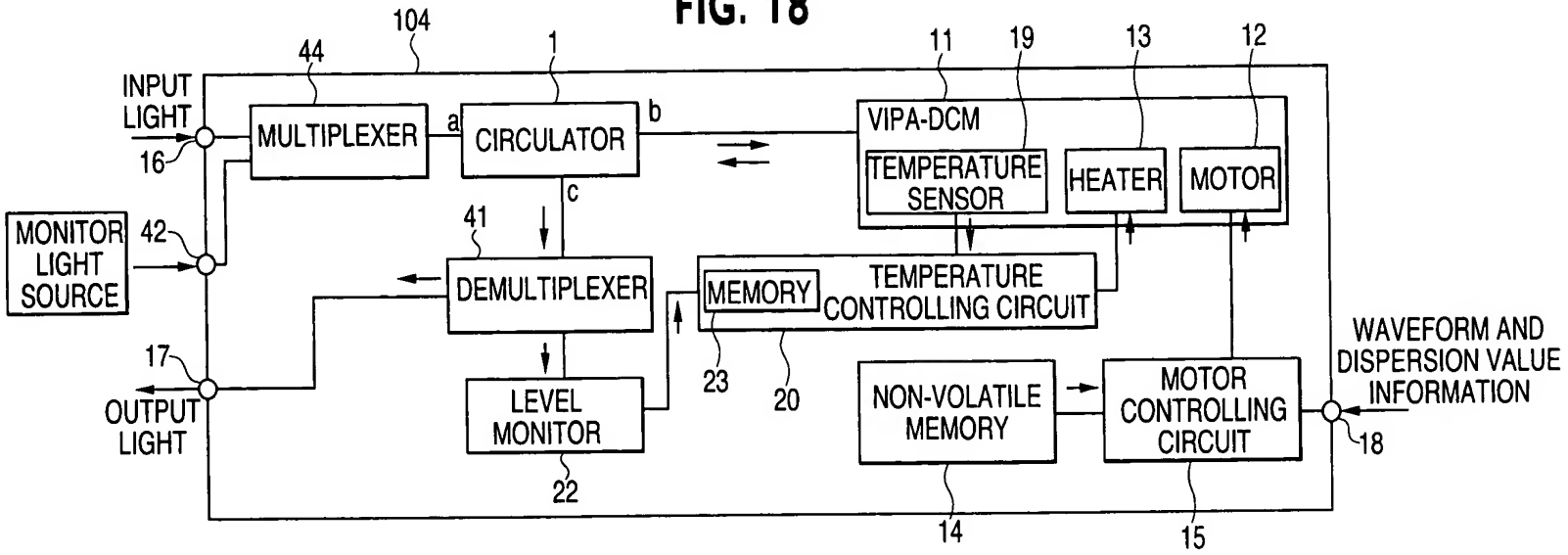

104
44
1
11
19
13
12
INPUT LIGHT
16
MULTIPLEXER
a
CIRCULATOR
b
VIPA-DCM
TEMPERATURE SENSOR
HEATER
MOTOR
c
41
MONITOR LIGHT SOURCE
42
DEMULTIPLEXER
MEMORY
TEMPERATURE CONTROLLING CIRCUIT
17
OUTPUT LIGHT
LEVEL MONITOR
23
20
NON-VOLATILE MEMORY
MOTOR CONTROLLING CIRCUIT
WAVEFORM AND DISPERSION VALUE INFORMATION
18
22
14
15

FIG. 19

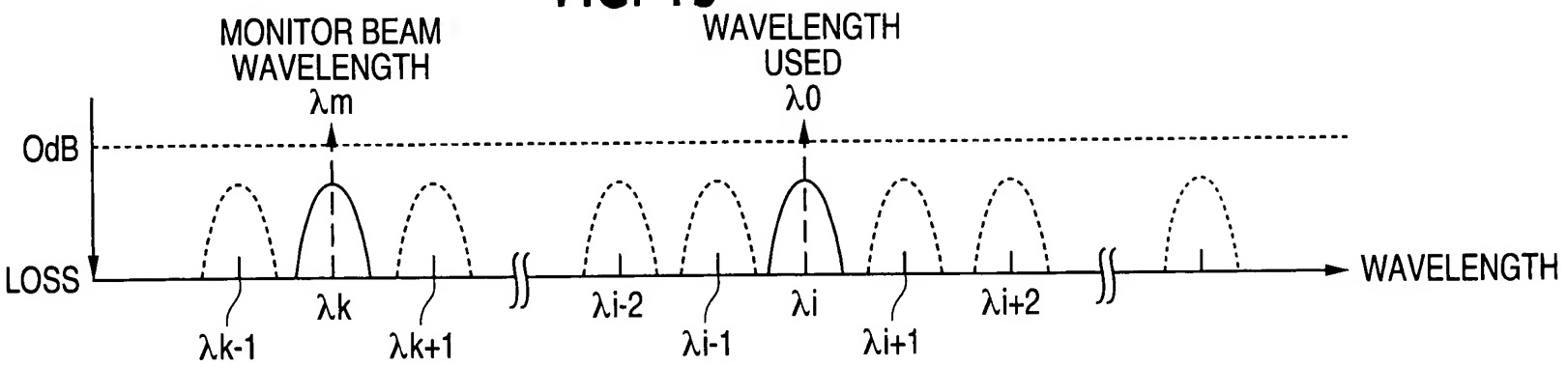

MONITOR BEAM WAVELENGTH
λm
WAVELENGTH USED
λ0
OdB
LOSS
WAVELENGTH
λk-1
λk
λk+1
λi-2
λi-1
λi
λi+1
λi+2

FIG. 20

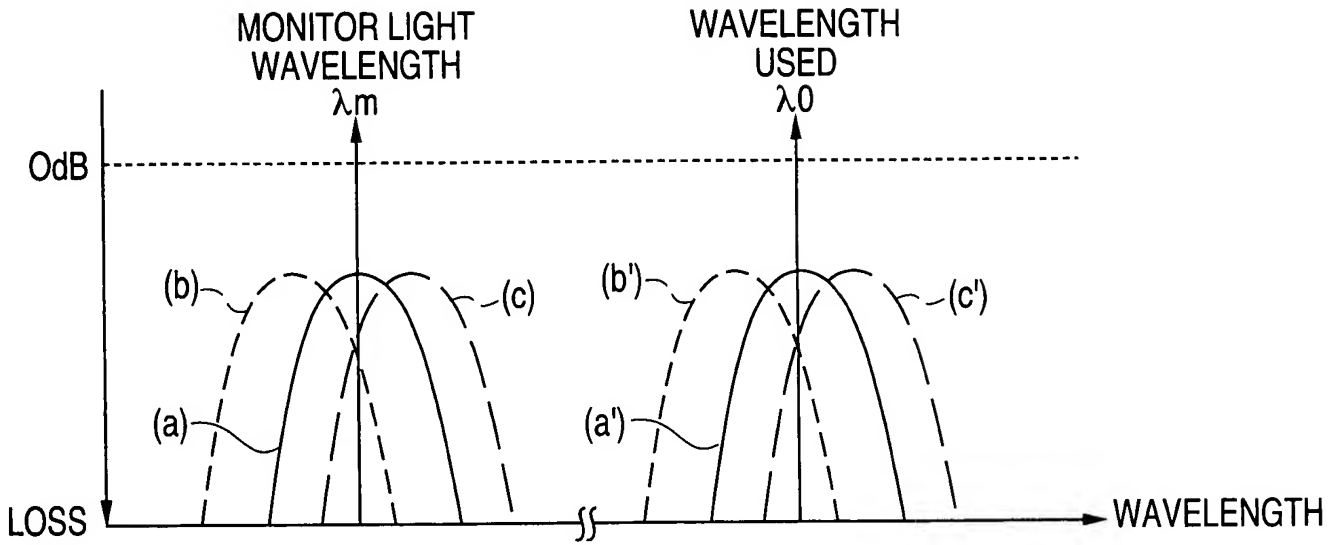

MONITOR LIGHT WAVELENGTH
λm
WAVELENGTH USED
λ0
OdB
(b)
(c)
(a)
(b')
(c')
(a')
LOSS
WAVELENGTH

FIG. 21

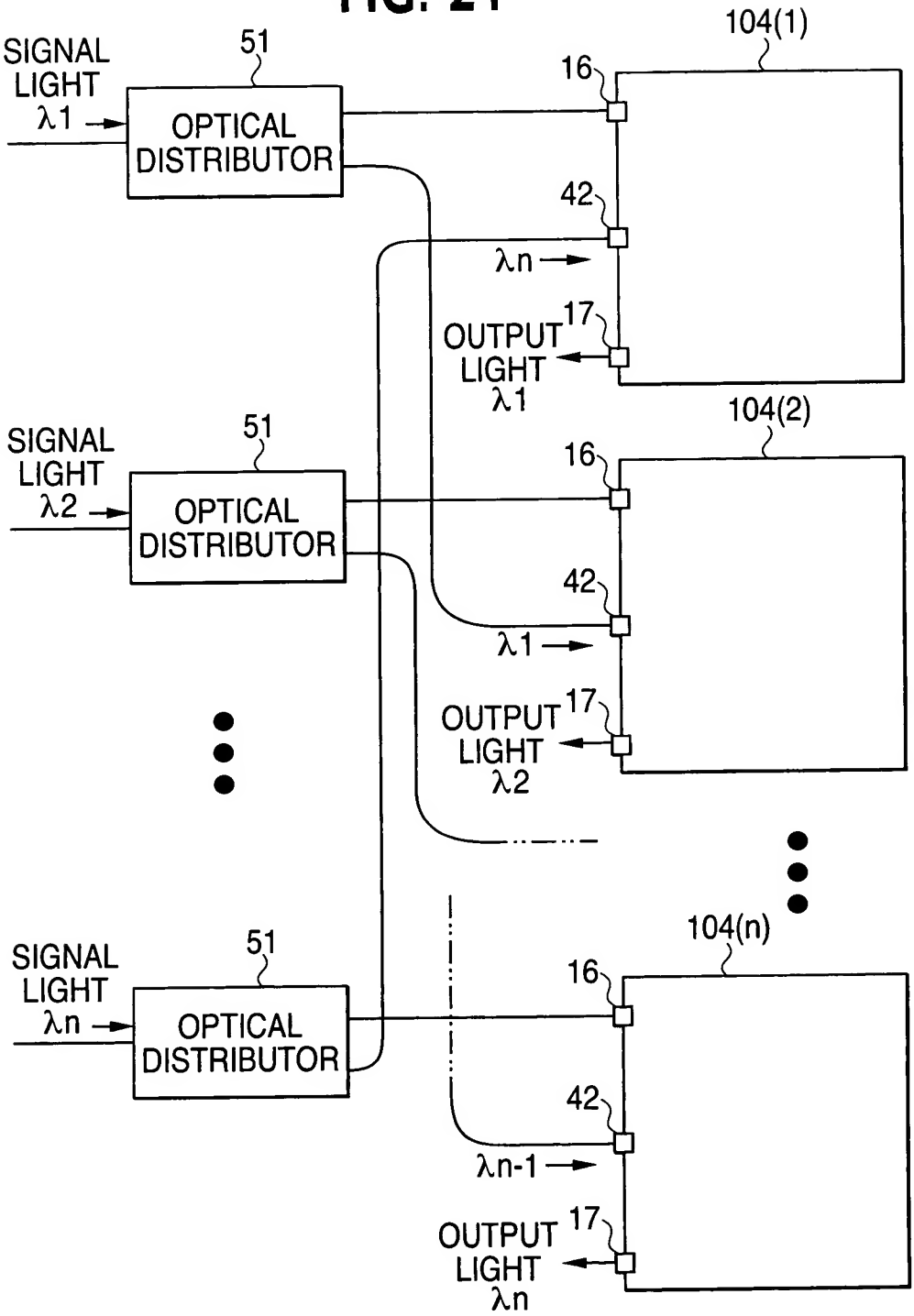

SIGNAL LIGHT λ1
51
OPTICAL DISTRIBUTOR
104(1)
16
42
λn
17
OUTPUT LIGHT λ1
SIGNAL LIGHT λ2
51
OPTICAL DISTRIBUTOR
104(2)
16
42
λ1
17
OUTPUT LIGHT λ2
SIGNAL LIGHT λn
51
OPTICAL DISTRIBUTOR
104(n)
16
42
λn-1
17
OUTPUT LIGHT λn

FIG. 22

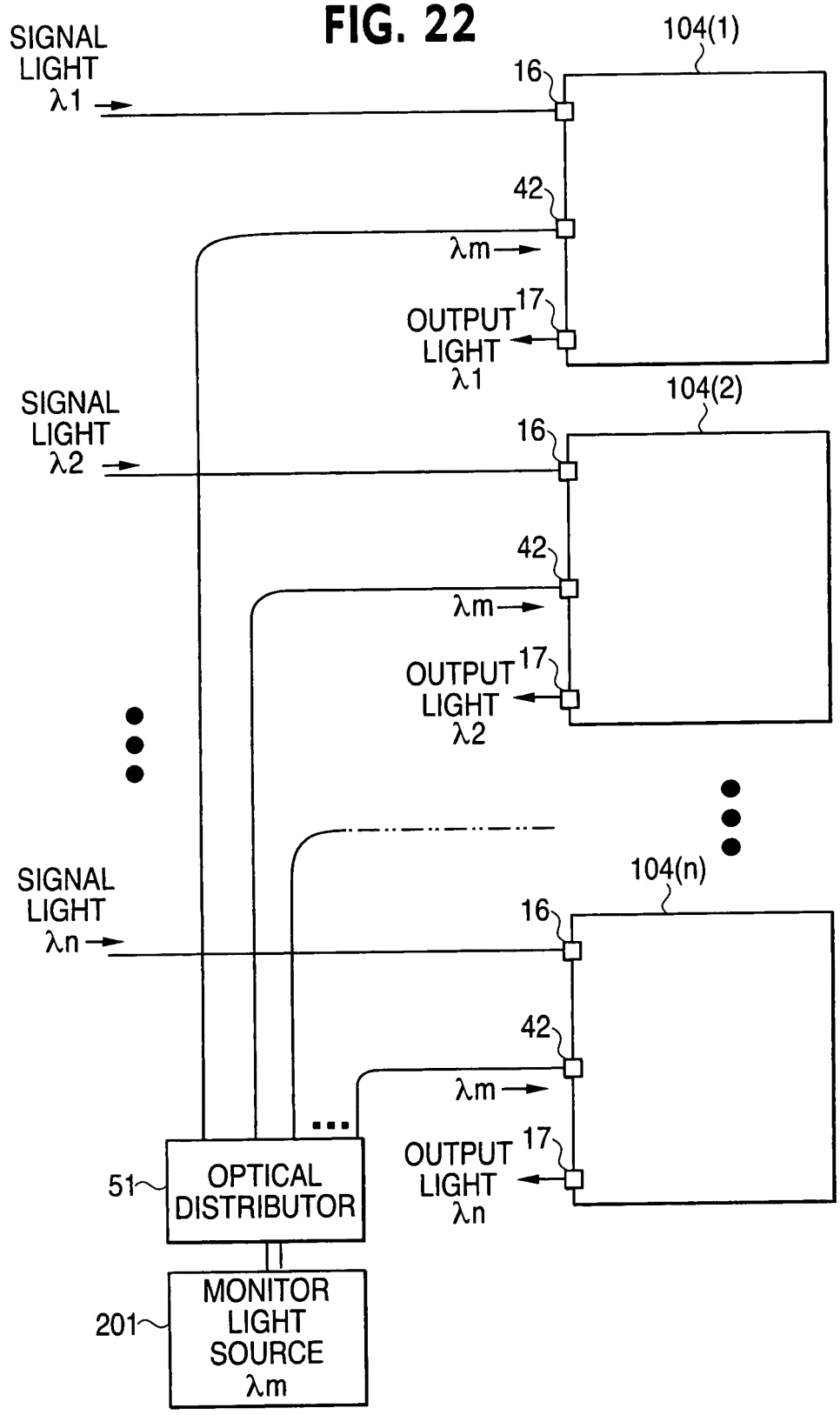

SIGNAL LIGHT λ1
104(1)
16
42
λm
17
OUTPUT LIGHT λ1
SIGNAL LIGHT λ2
104(2)
16
42
λm
17
OUTPUT LIGHT λ2
SIGNAL LIGHT λn
104(n)
16
42
λm
17
OUTPUT LIGHT λn
51
OPTICAL DISTRIBUTOR
201
MONITOR LIGHT SOURCE λm

FIG. 23

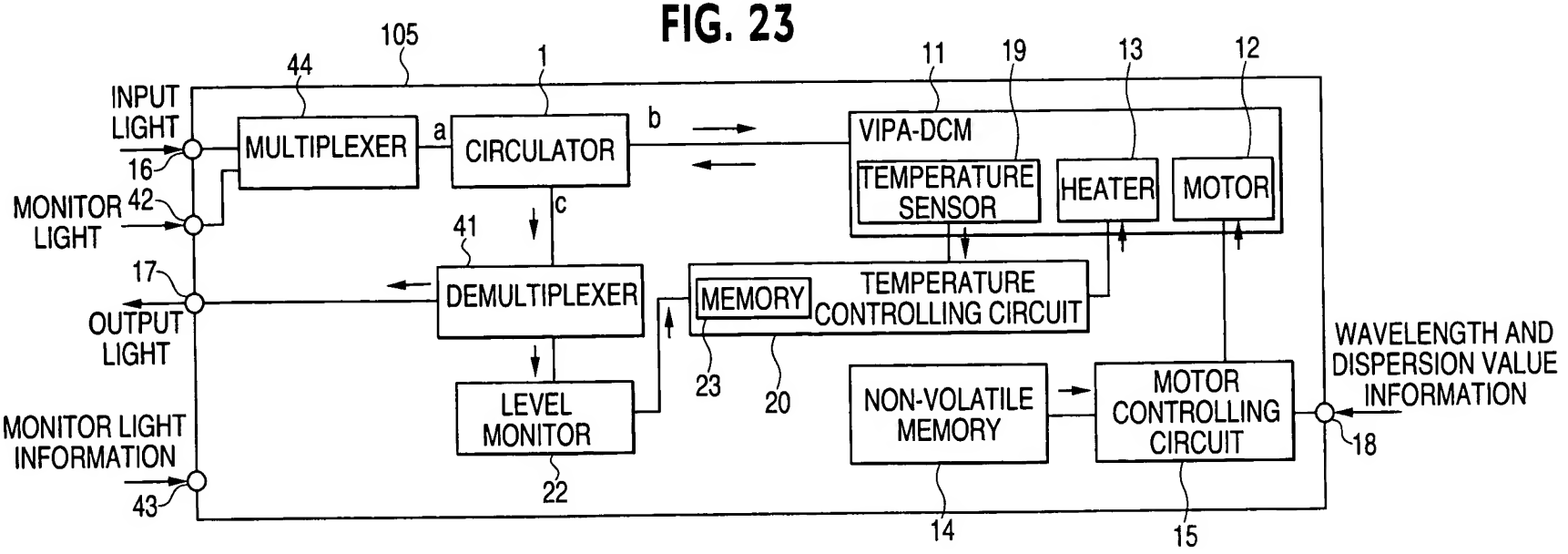

105
44
1
11
19
13
12
INPUT LIGHT
16
MULTIPLEXER
a
CIRCULATOR
b
VIPA-DCM
TEMPERATURE SENSOR
HEATER
MOTOR
MONITOR LIGHT
42
c
41
17
DEMULTIPLEXER
MEMORY
TEMPERATURE CONTROLLING CIRCUIT
OUTPUT LIGHT
WAVELENGTH AND DISPERSION VALUE INFORMATION
LEVEL MONITOR
23
20
NON-VOLATILE MEMORY
MOTOR CONTROLLING CIRCUIT
18
MONITOR LIGHT INFORMATION
43
22
14
15

FIG. 24

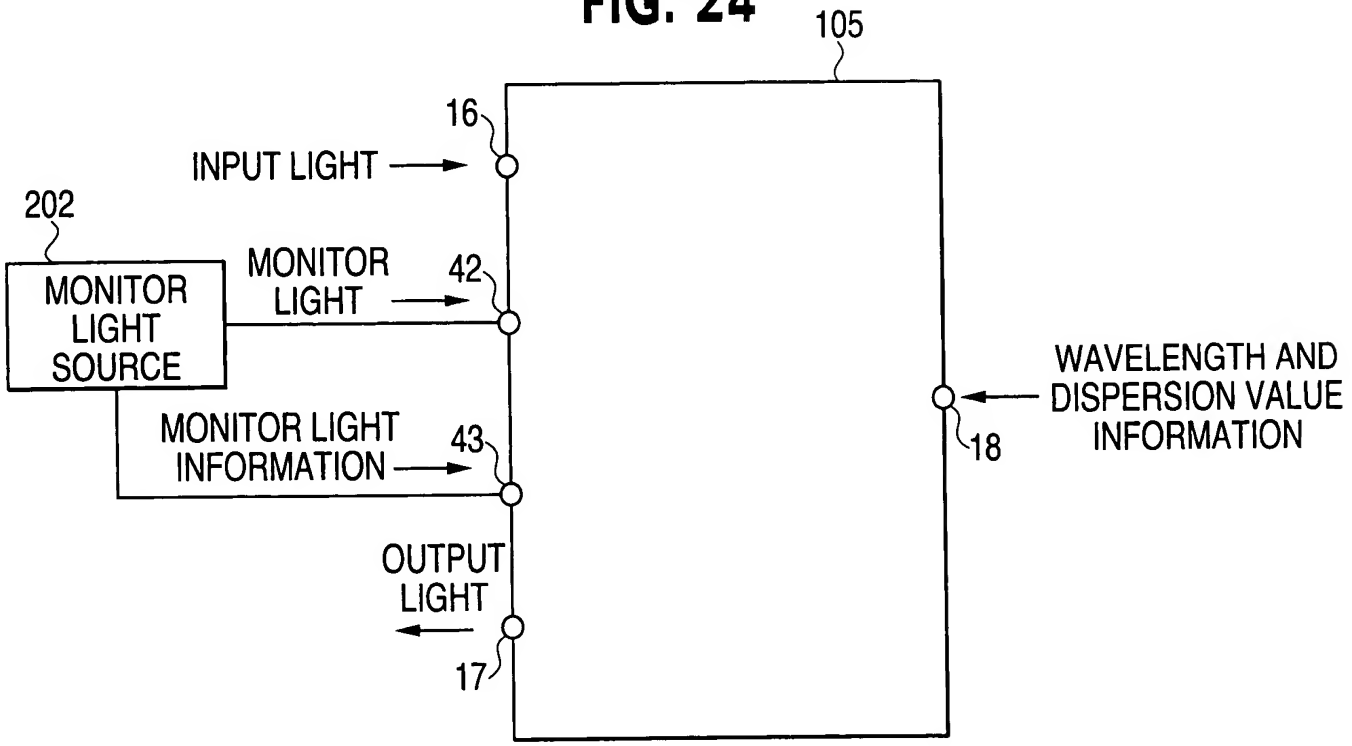

105
16
INPUT LIGHT
202
MONITOR LIGHT SOURCE
MONITOR LIGHT
42
MONITOR LIGHT INFORMATION
43
OUTPUT LIGHT
17
WAVELENGTH AND DISPERSION VALUE INFORMATION
18

FIG. 25

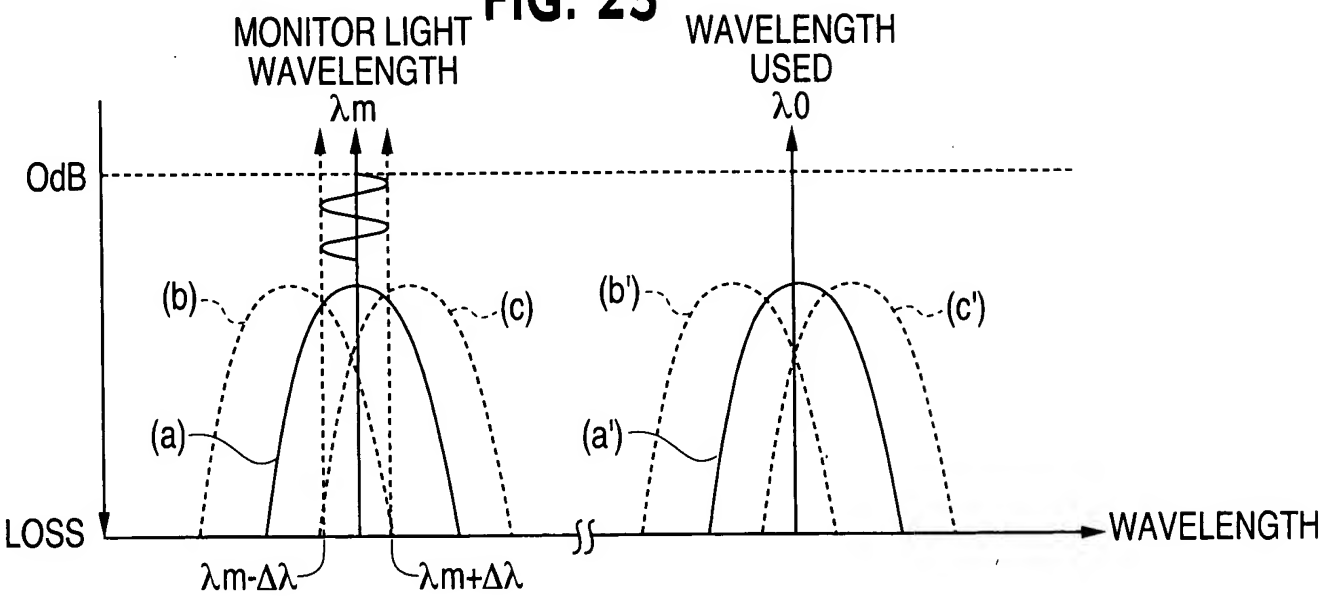

MONITOR LIGHT WAVELENGTH
λm
WAVELENGTH USED
λ0
OdB
(b)
(c)
(a)
(b')
(c')
(a')
LOSS
λm-Δλ
λm+Δλ
WAVELENGTH

FIG. 26(a)

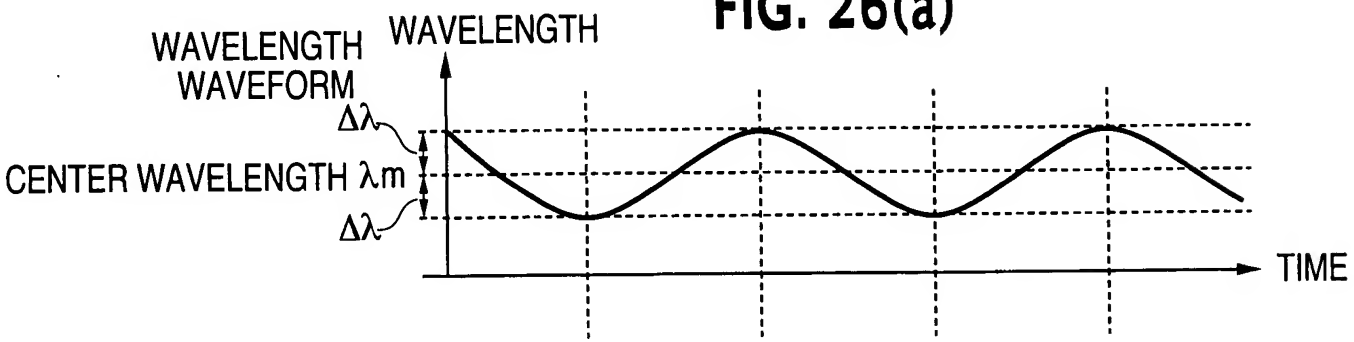


FIG. 26(b)

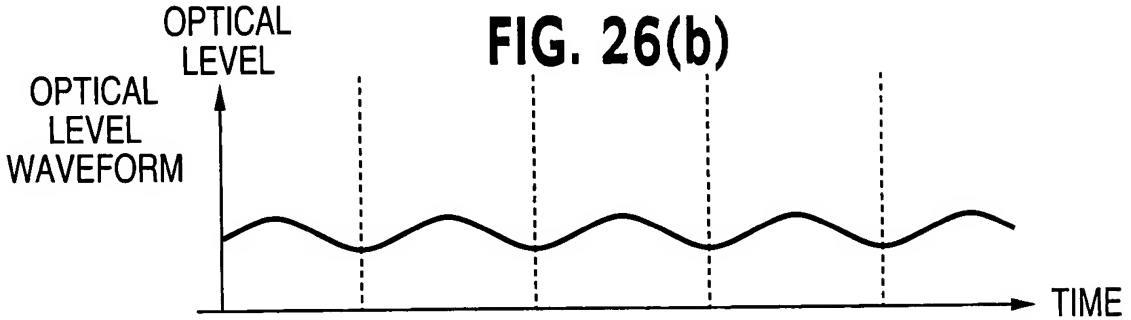


FIG. 27(a)

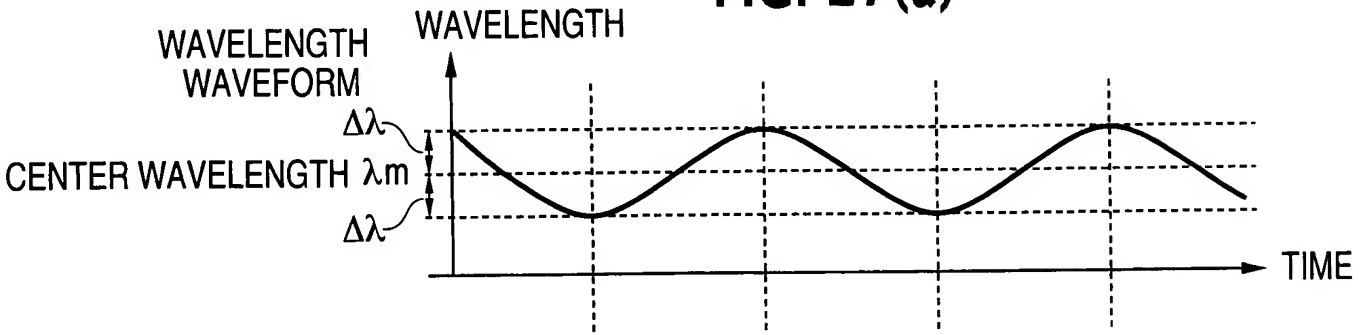


FIG. 27(b)

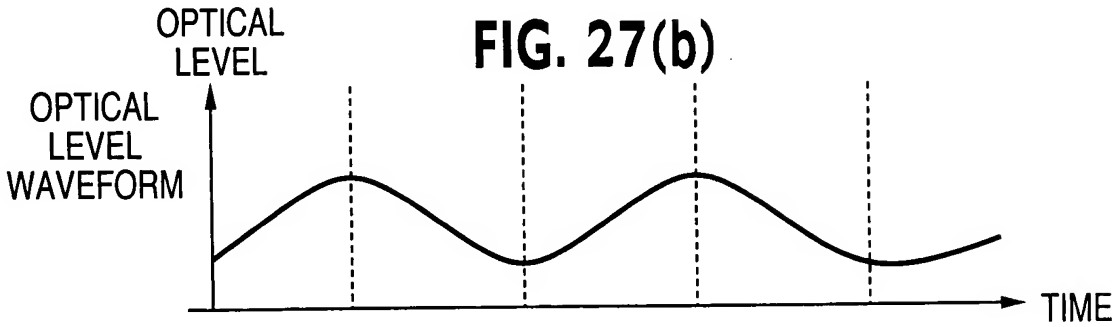


FIG. 28(a)

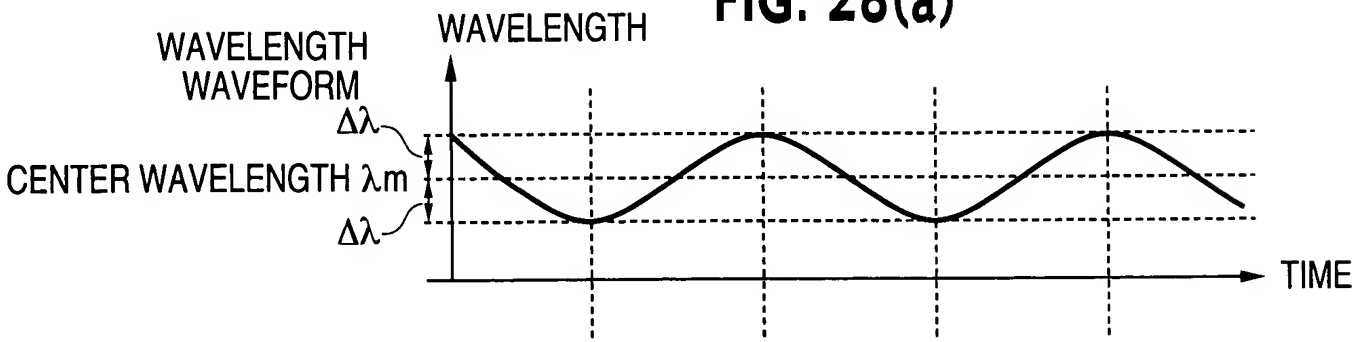


FIG. 28(b)

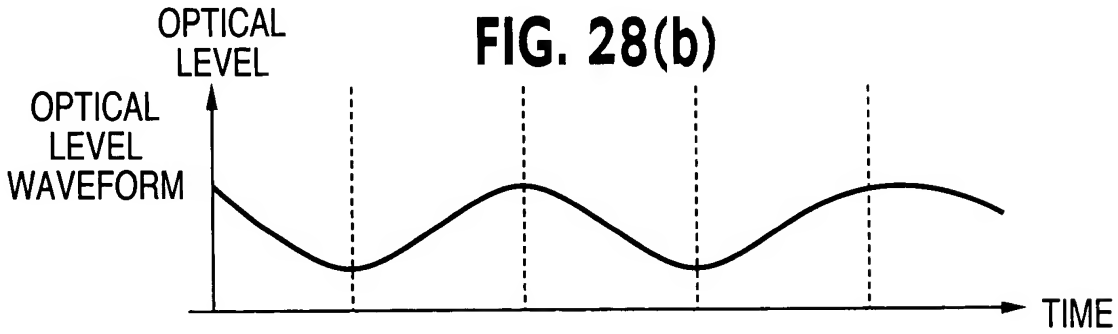


FIG. 29

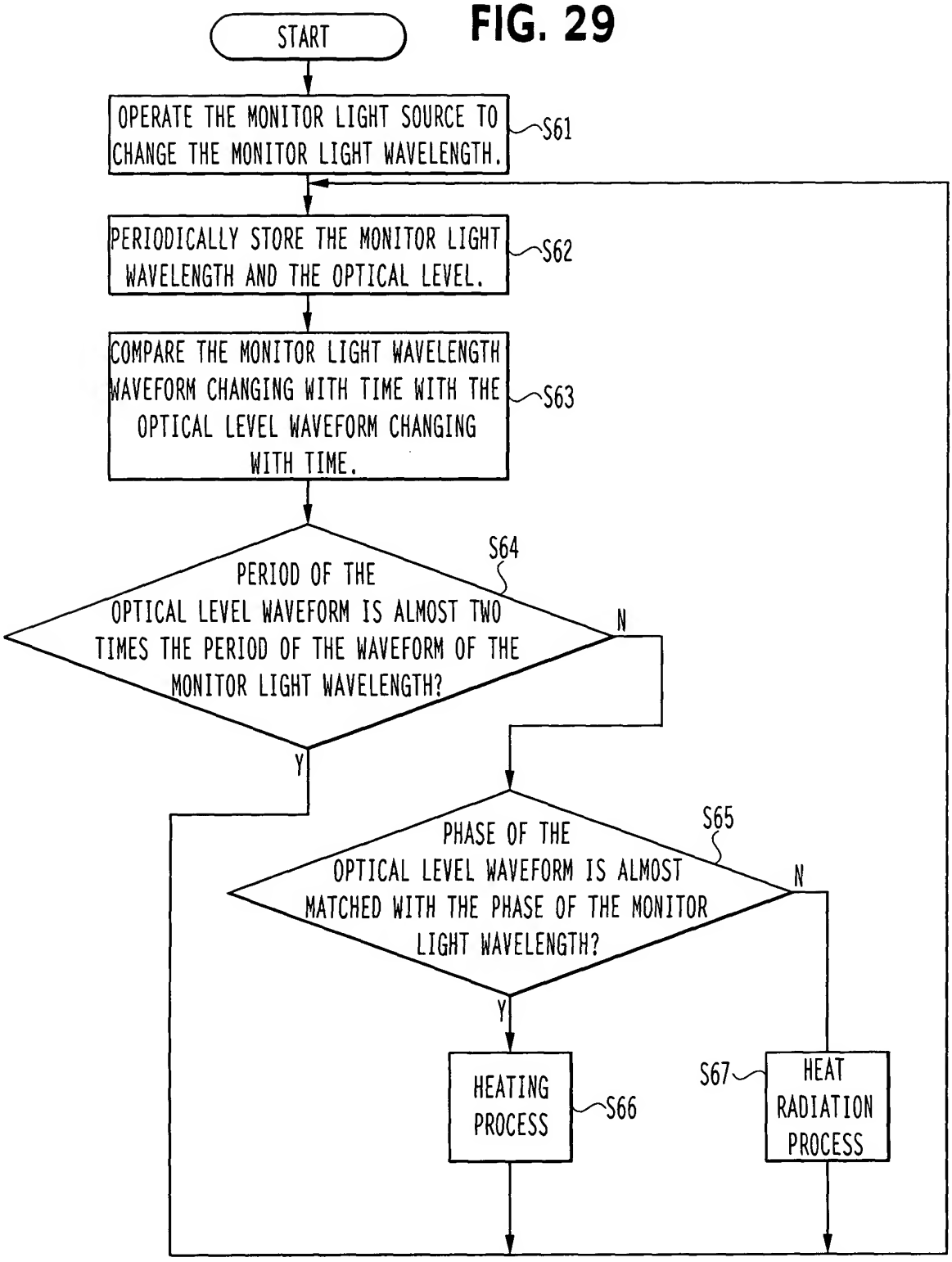

START
OPERATE THE MONITOR LIGHT SOURCE TO CHANGE THE MONITOR LIGHT WAVELENGTH.
S61
PERIODICALLY STORE THE MONITOR LIGHT WAVELENGTH AND THE OPTICAL LEVEL.
S62
COMPARE THE MONITOR LIGHT WAVELENGTH WAVEFORM CHANGING WITH TIME WITH THE OPTICAL LEVEL WAVEFORM CHANGING WITH TIME.
S63
S64
PERIOD OF THE OPTICAL LEVEL WAVEFORM IS ALMOST TWO TIMES THE PERIOD OF THE WAVEFORM OF THE MONITOR LIGHT WAVELENGTH?
N
Y
S65
PHASE OF THE OPTICAL LEVEL WAVEFORM IS ALMOST MATCHED WITH THE PHASE OF THE MONITOR LIGHT WAVELENGTH?
N
Y
HEATING PROCESS
S66
S67
HEAT RADIATION PROCESS

FIG. 30

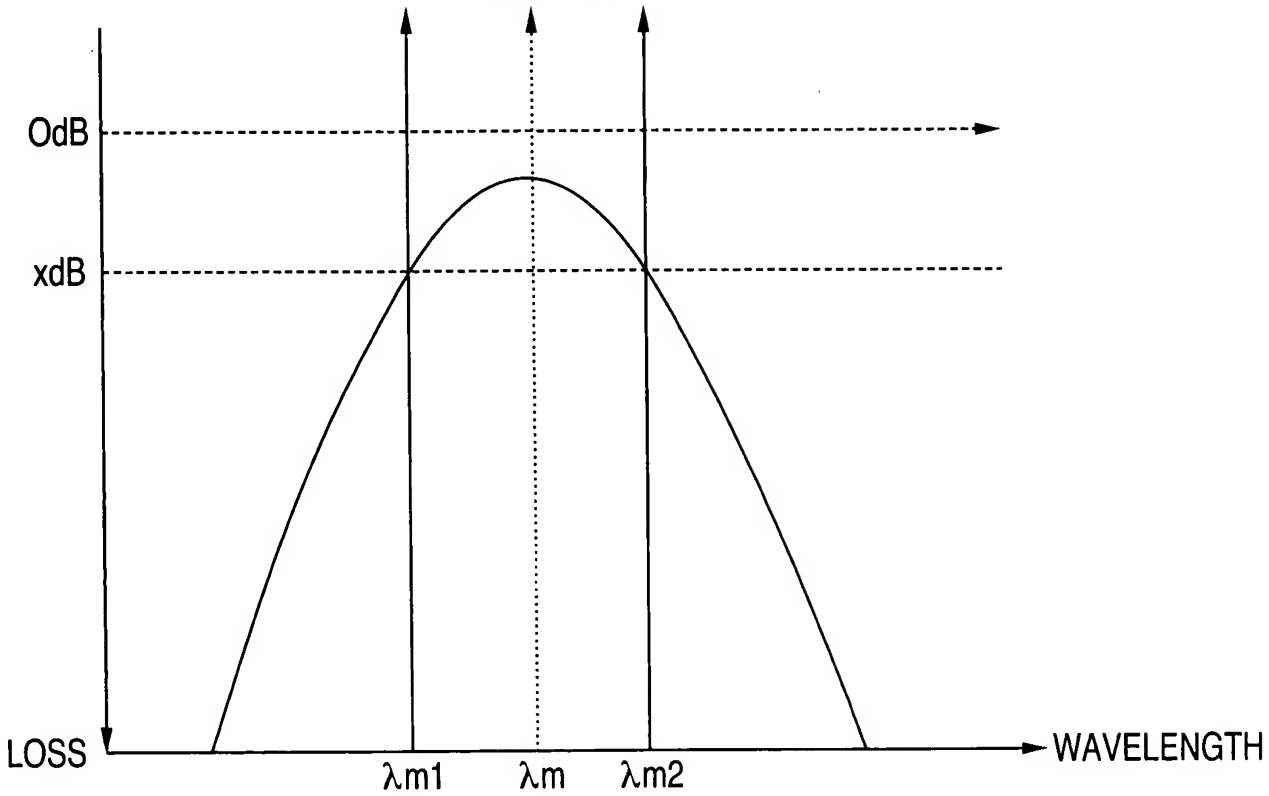


FIG. 31

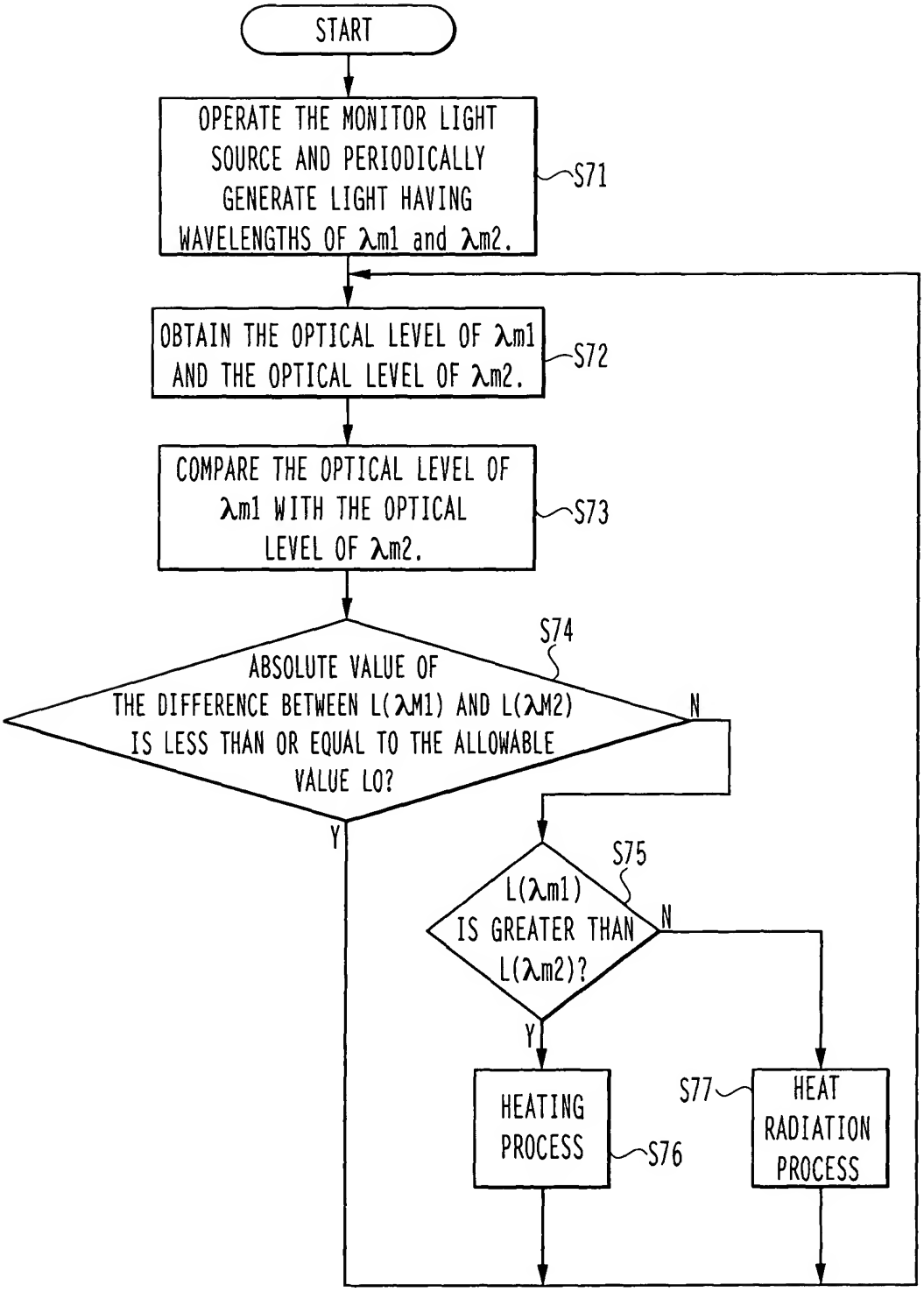

START
OPERATE THE MONITOR LIGHT SOURCE AND PERIODICALLY GENERATE LIGHT HAVING WAVELENGTHS OF λm1 and λm2.
S71
OBTAIN THE OPTICAL LEVEL OF λm1 AND THE OPTICAL LEVEL OF λm2.
S72
COMPARE THE OPTICAL LEVEL OF λm1 WITH THE OPTICAL LEVEL OF λm2.
S73
S74
ABSOLUTE VALUE OF THE DIFFERENCE BETWEEN L(λM1) AND L(λM2) IS LESS THAN OR EQUAL TO THE ALLOWABLE VALUE LO?
N
Y
S75
L(λm1) IS GREATER THAN L(λm2)?
N
Y
HEATING PROCESS
S76
S77
HEAT RADIATION PROCESS

FIG. 32(a)

ABSOLUTE VALUE OF THE DIFFERENCE BETWEEN L(λm1) AND L(λm2) IS L0 OR LESS.

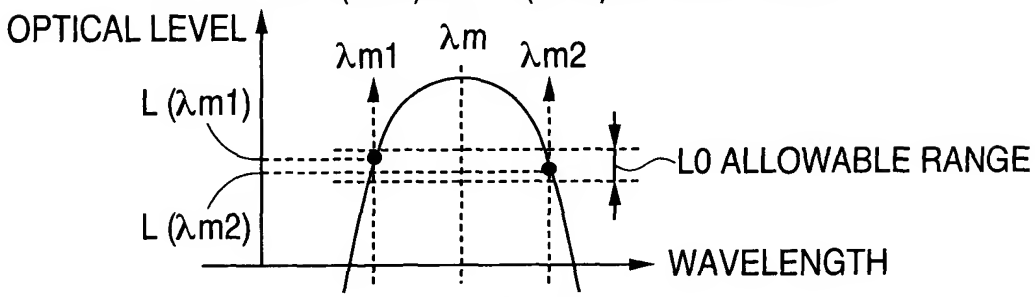


FIG. 32(b)

WHEN L(λm1) > L(λm2)

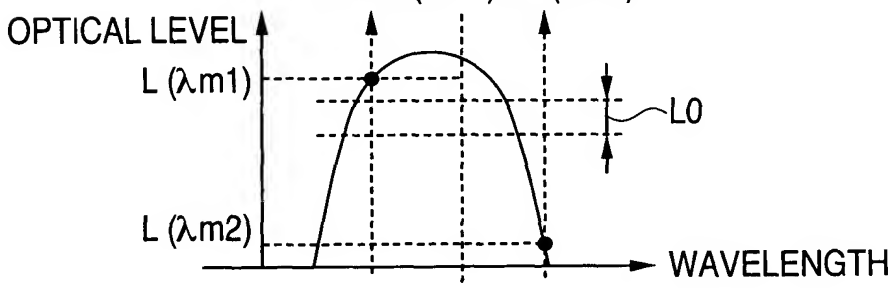


FIG. 32(c)

WHEN L(λm1) < L(λm2)

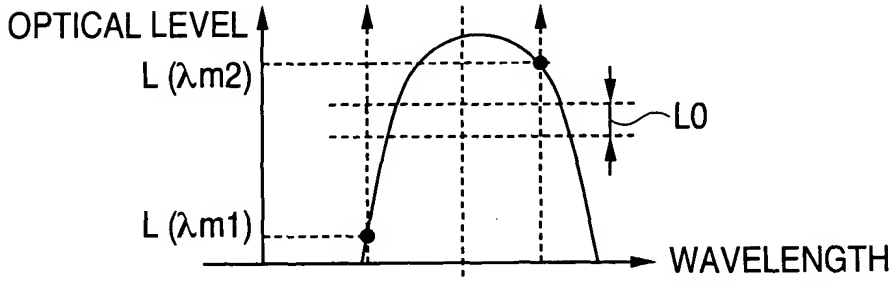
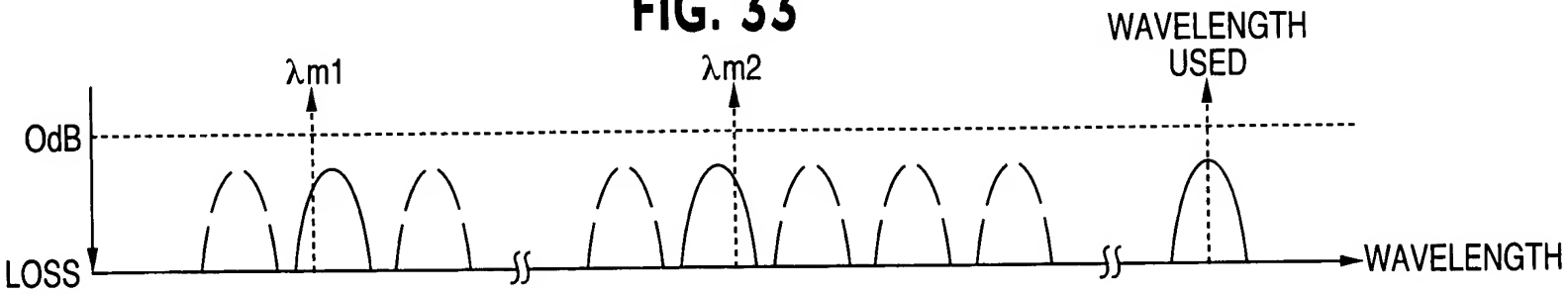



FIG. 33